The genus *Calyptraea* (Gastropoda, Caenogastropoda, Calyptraeidae) in the East Atlantic

El género *Calyptraea* (Gastropoda, Caenogastropoda, Calyptraeidae) en el Atlántico oriental

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ABSTRACT

The genus *Calyptraea* is revised for the East Atlantic. Up to now, only *C. chinensis* was recognized but this species is only present in the Mediterranean Sea, and in the European and North African Atlantic. Two new African species confused up to now with *C. chinensis* are described, one with a range from Western Sahara to Guinea Conakry and Benin, and the other from Mauritania to Angola. Another South African species, also considered *C. chinensis*, is in fact a different taxon.

RESUMEN

Se revisa el género *Calyptraea* en el Atlántico oriental. *Calyptraea chinensis*, la única especie reconocida actualmente, se distribuye sólo en el Mediterráneo, y en el Atlántico europeo y norteafricano. Dos nuevas especies, hasta ahora consideradas como *C. chinensis*, se encuentran en África; una de ellas se extiende desde el Sáhara Occidental hasta Guinea Conakry y Benin, y otra desde Mauritania hasta Angola. Otra especie de Sudáfrica, también considerada hasta el momento como *C. chinensis*, es una especie diferente.

KEY WORDS: *Calyptraea chinensis*, Europe, West Africa, new species.
PALABRAS CLAVE: *Calyptraea chinensis*, Europa, África occidental, nuevas especies.

INTRODUCTION

The genus *Calyptraea* Lamarck, 1799 is represented in the East Atlantic by only one species, in the opinion of most recent authors (Nicklès, 1950; Bernard, 1984; Fretter and Graham, 1981; Sabelli, Giannuzzi-Savelli and Bedulli, 1991; Poppe and Goto, 1991; Rolán and Ryall, 1999 and Chiarelli, 2002). Against this recent situation, more species of this genus are known from the fossil records (Castaño, Civis and González Delgado, 1988; Vera-Peláez, Lozano-Francisco, Muñiz-Solís, Gili, Martinell, Domènech, Palmqvist and Guerra-Merchán, 1995). The systematics and the phylogeny of the genus *Calyptraea* were studied by Fischer (1950).

Being a common species with a wide distribution, it was to be expected that some of the names employed in the past to designate *C. chinensis* are actually synonyms (most from the Mediterranean) (see Sabelli *et al.*, 1991 and below).

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A general description of this species is given in FRETTER AND GRAHAM (1962, 1981) together with bibliographic information on different aspects. Other references to this species will be mentioned below under distribution.

After studying numerous samples of material from many European and West African localities, the comparison of shells, anatomy and other characters indicated the existence of more than one species. This is the subject of the present work.

MATERIAL AND METHODS

Some of the material examined as well as numerous specimens and shells were obtained by the author from expeditions to several West African localities: Morocco, Mauritania, Canary Islands, Senegal, Ghana, São Tomé Is., Principe Is., Annobón Is. and Angola. Many samples from the MNHN collection and also from some private collections mentioned below were also studied. *In vivo* observations were made by the author.

Abbreviations

AMNH American Museum of Natural History, New York
BMNH The Natural History Museum, London
IPM Instituto Português de Malacologia, Lisbon
LS Linnean Society, London
MNCN Museo Nacional de Ciencias Naturales, Madrid
MNHN Muséum Nationale d'Histoire Naturelle, Paris
ZSM Zoologisch Staatssammlung, München
CJH collection of José María Hernández, Gran Canaria
CER collection of Emilio Rolán, Vigo
CFS collection of Frank Swinnen, Lommel, Belgium
sp specimen with soft parts
s shell
f fragment
j juvenile. As the smaller specimens are adult males (BACCI, 1951), only in very small shells was the category of juvenile employed.

RESULTS

Family CALYPTRAEIDAE Lamarck, 1809
Genus *Calyptraea* Lamarck, 1799

Calyptraea chinensis (Linnaeus, 1758) (Figs. 1-27, 65-67, 83-85, 91, 94, 97, 100, 103-107, 113-116)

Patella chinensis Linnaeus, 1758. *Syst. Nat.*, ed. X, p. 781, no. 656; ed. XII, p. 1257, no. 749. [Type locality: M. Mediterraneo].
Patella sinensis Gmelin, 1791. *Syst. Nat.*, ed. XIII, p. 3692.
Patella albida Donovan, 1802. *Nat. hist. Brit. Shells*, IV, pl. 129.
Patella squamulata Renier, 1804. *Prodr. Observ.* [not available: published in a paper rejected by ICZN opinion 316/1954].
Patella muricata Brocchi, 1814. *Conch. foss. subap.*, p. 16.
Calyptraea laevigata Lamarck, 1822. *Hist. nat. anim. sans vert.* VI, II, p. 21.
Calyptraea succinea Risso, 1826. *Hist. Nat. Eur. Mer.*, p. 255.
Calyptraea vulgaris Philippi, 1836. *Enum. moll. Siciliae*, I, p. 119.
Calyptraea polii Scacchi, 1836. *Catal. Conch. Regn. Neapolitani*, p. 17.
Calyptraea spirata Nardo, 1847. *Sinon. modern...Golfo Veneto.* In SABELLI *ET AL.* (1990), p. 160.
Calyptraea canarica Buonanni *fide* JEFFREYS (1865). *Brit. Conch.*, 3, p. 275.
Calyptraea mamma Krynicki *fide* Middendorff in JEFFREYS (1865). *Brit. Conch.* 3, p. 276.
Calyptraea polii var. *fusca* Issel, 1878. *Croc. del Viol.*-Testacei, p. 31.
Calyptraea sinensis var. *coralligena* Pallary, 1900. *Coquil. marins d'Oran*, p. 329.
Calyptraea sinensis var. *elliptica* Pallary, 1900. *Coquil. marins d'Oran*, p. 329.

Type material: 2 syntypes, in LS (Figs. 113-116); the larger one is here designated lectotype (Figs. 113, 114)

Other material examined: Great Britain: 36 s, Shells Bay, Studtland, Dorset (MNHN). Atlantic France: 15 s, Saint Michel, Normandy, in shells on sand, intertidal (CER); 15 sp, 16 s, 10 j, Les Cochons Noires, Roscoff, Finistère, 20 m (MNHN); 4 sp, Roscoff, on shells of sand bottom, intertidal (CER); 3 c, NE canyon de la Cassidaigne 48° 06.7′ N 05° 55′ E, 150-250 m (MNHN); 35 sp, Saint Quay Portrieux, Baie de Saint Brieuc, 10-30 m, on shells (CER); 4 s, Plougastel, Tinduff, port (MNHN); 33 s, Anse de Bertheaume, 20-30 m (MNHN). Atlantic Spain: 40 sp, Ribadeo, intertidal, on shells (CER); 12 sp, 23 s, Vigo, Samil, 12 m, on shells and rocks (CER); 155 sp, 30 s, O Grove, on shells, sandy bottom, intertidal (CER); 53 sp, 30 s, Vigo, Cies Islands, 9 m, on shells and rocks (CER); 20 sp, Punta do Arroás, Vigo, intertidal (CER); 3 s, Vigo, San Simón, 5 m, on shells, sandy bottom (CER); 55 sp, Vigo, Toralla, 20 m, on shells, sandy bottom (CER); 3 j, Conil de la Frontera (MNHN); 6 s, Cádiz Bay, 18 m, from sandy sediment (CER); 1 c, El Puerto de Santa María, Cádiz, beach sediment (MNHN); 6 s, Sotogrande, Torre Guadiaro, Cádiz, circalittoral (MNHN); 15 c, Torre de la Peña, Tarifa, in beach sediment (MNHN). Portugal: 30 sp, 9 s, Tavira, Terra Estreita 37° 06′ N 07° 38.4′ W, 3 m (MNHN); 2 sp, Ria Formosa, Ilha do Farol, Casi dos Hangares, 3 m (IPM); 6 sp, 7 s, Algarve, between Sagres and Faro, 40-50 m (MNHN); 106 sp, 70 c, Chenal do Olhão, 37° 00′ N 07° 51′ W, 3-7 m (MNHN); 6 sp, 12 s, Baia de Baleeira, 37° 00.7′ N 8° 55′ W, 12-17 m (MNHN); 20 sp, 8 s, Baia do Peixe, 37° 00′ N 08° 58′ W, 23 m (MNHN); 1 sp, Algarve 36° 56′ 871″N 08° 17′ 45″W, 69-105 m (IPM). Mediterranean Spain: 114 sp, 165 s, La Atunara, La Línea de la Concepción, 27 m, on shells, in sandy bottom (CER); 2 s, La Atunara Beach, La Línea, 36° 10.2′ N 05° 19.3′ W, 30 m (MNHN); 1 s, La Atunara Beach, La Línea, 36° 05.19′ N 05° 19′ W, 40-45 m (MNHN); 15 s, Málaga, 20-40 m (MNHN); 5 sp, 23 s, 30 j, Rincón de la Victoria, Málaga (MNHN); 4 s, Marbella port (MNHN); 3 s, Marbella (CJH); 1 c, Tarajal, Ceuta (MNHN). Mediterranean France: 5 c, Lion Gulf, N/O "Europe" IFREMER/DEPRO 96, 42° 20′ N 03° 27.1′ W, 650-725 m (MNHN); 2 sp, Lacaze-Duthiers, Banyuls-ECOMARGE, 42° 30′ N 03° 25.20E, 130-190 m (MNHN); 2 sp, Cap Béar, Banyuls-ECOMARGE, 42° 29.40′ N 03° 10.40E, 66-67 m (MNHN); 1 sp, Cap Béar, Banyuls-ECOMARGE, 42° 30′ N 03° 10.50E, 62 m (MNHN); 7 sp, 1 sp, Cap Béar, Banyuls-ECOMARGE, 42° 31′ N 03° 10.10E, 70 m (MNHN); 39 s, Marseille N/O "Georges Petit", Grand Congloué, 83 m (MNHN); 7 s, Le Brusc/Cap Sicié, Provenza, 40-100 m (MNHN). Morocco: 13 c, Playa Grande, Tanger (MNHN); 1s, Essaouira, 31° 31′ N 09° 47′ W, beach sediment 2 sp, Cap Béar, Banyuls-ECOMARGE, 42° 29.40′ N 03° 10.40E, 66-67 m (MNHN); 1 c, 16 j, N/O Vanneau, 30° 40′ N 04° 55′ W, 20 m (MNHN); 3 sp, 4 c, 7 j, N/O Vanneau, 30° 30′ N 09° 43′ W, 40 m (MNHN); about 300 s and j, N/O Vanneau, 34° 54′ N 09° 58′ W, 110 m (MNHN); 4 s, N′ Dig (Rincon), circalittoral (MNHN); 3 s, 10 km N Agadir (CFS). Algeria: 3 s, (MNHN); 1 sp, 1 s, 1 j, Oran (MNHN). Italy: 4 c, Tuscan archipelago (MNHN); 12 s, Naples (MNHN); 2 s, Palermo and Messina (MNHN). Tunis: 3 s, Canal d′ Ajim, Djerba, 10-32 m (MNHN); 56 c, Gulf of Gabes, 10-15 m (MNHN). Rumania: 4 sp (MNHN). Madeira: 19 s, Pontinha-Cais do Lazareto, 60 m (CFS); 14 s, Lido, Funchal (CFS); 26 c, Funchal Bay (CFS); 15 s, Funchal Bay, 25-30 m (CFS); 22 s, Funchal Bay, 50 m (CFS); 26 s, 1 f, Funchal Bay, 70-80 m (CFS); 12 s, Funchal Bay, 100 m (CFS); 3 s, Funchal Bay, 130 m (CFS); 3 s, Funchal Bay, 150 m (CFS); 4 s, Funchal Bay, 180 m (CFS). Canary Islands: 2 s, Gando Bay, Gran Canaria, 15 m (CFS); 2 s, Maspalomas, Gran Canaria (CFS). Western Sahara: 6 s, S. Peña Grande, 24° 45′ N 15° 25′ W (CJH); 1 s, Villacisneros, 30 m (CJH).

Description: The original description of Linnaeus is: "*Testa integra subconica laevi labio laterali*". For a more complete description, see FRETTER AND GRAHAM (1981). The shell (Figs. 1-10) has been illustrated in many papers, but the colour variability was only well represented in GIANNUZZI-SAVELLI *ET AL.* (1997) and MACEDA *ET AL.* (1999). The protoconch (Figs. 11-26) is described in FRETTER AND GRAHAM (1981) as "having 0.75 to 1 smooth whorls but this is often eroded.... The protoconch is not clearly separated from the teleoconch. Its diameter is 600-700 µm". This description is correct but the nucleus of the protoconch, according to the definition of VERDUIN (1976), has between 194 and 230 µm. From this nucleus, the protoconch increases in size quickly to reach 3-3.5 times the diameter of the nucleus, and 0.75 to 1 whorl at its end, although the limit with the teleoconch is not clearly defined. The total diameter of the protoconch in the shells studied was between 630 and 741 µm. Seen from the

side the protoconch is situated on the teleoconch without a deep suture between them. Its surface is apparently smooth but, at high magnification (Figs. 19, 24, 26), numerous, short axial striae disposed in spiral bands may be observed. This description is valid for 98% of the more than three hundred protoconchs studied: for some variations, see below, in Remarks. The teleoconch is rather smooth, of a patelliform shape, rounded, rather solid, opaque and not glossy. Ratio between width and height is usually between 2.5 and 3.1. Only exceptional populations may have differences in shape, the shells being higher or flatter (see below). Many shells are smooth, not shiny, with or without prominences, sometimes with oblique dorsal threads near the border. Within the same populations, a variable number of shells show scarcely separated prominent spines (Figs. 10, 100).

The colour of the shell is most frequently white but it may be yellowish, cream, pink, brown or violet. The colour of each population is variable, with white or brown sometimes predominating.

Dimensions: FRETTER AND GRAHAM (1981) indicated up to 15 mm, which is similar to the maximum dimension mentioned in most papers; LOCARD (1892) mentions up to 20 mm. After examining many specimens, it is uncommon for the species to reach more that 20 mm, but there is a shell (CER) from Pobra do Caramiñal, north-west Spain, with a diameter of 24.7 mm; in the MNHN there is another from Málaga of 25 mm and, finally, the record is in CJH where there is a shell from Malaga of 30 mm in diameter.

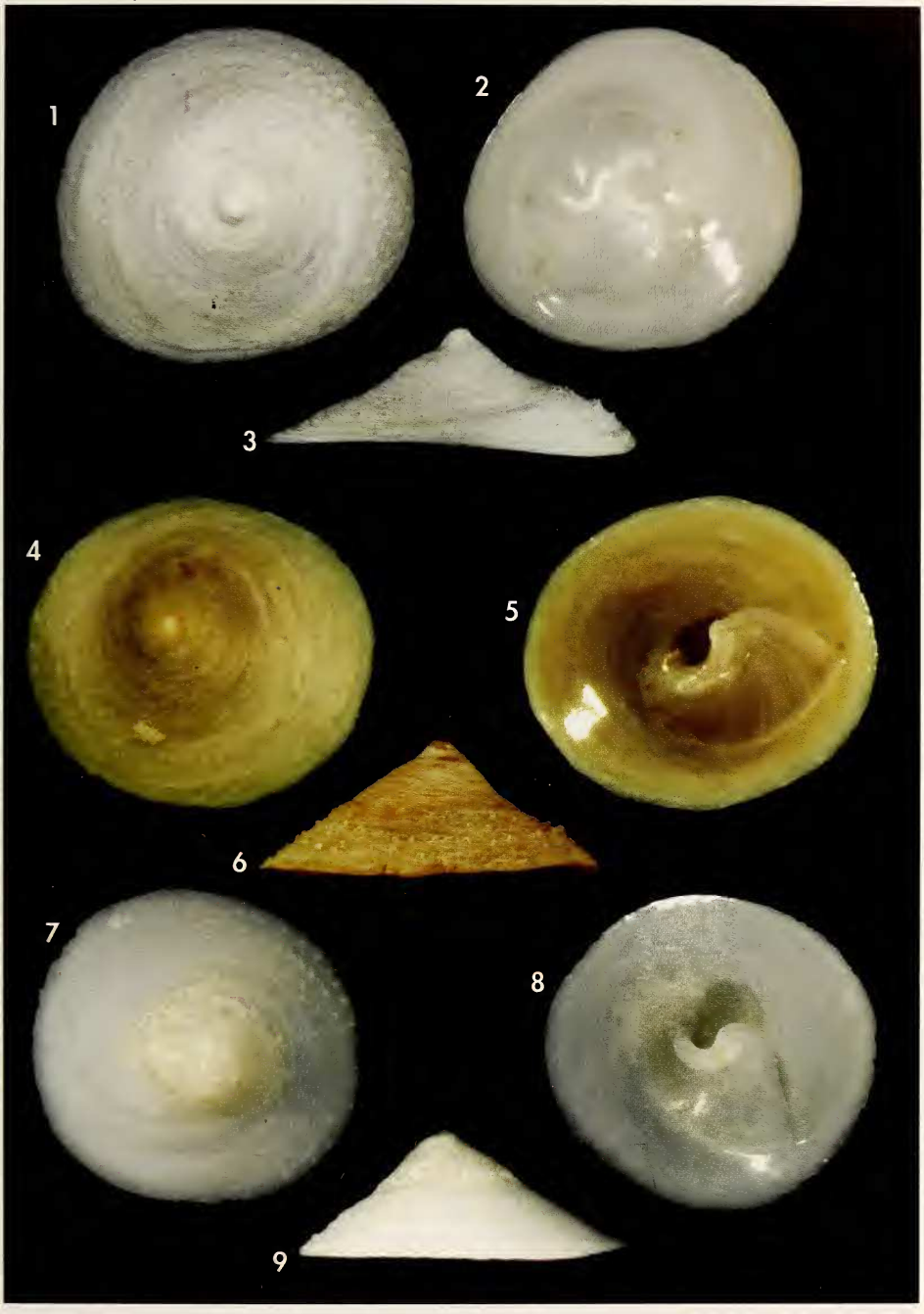
The animal was described in FRETTER AND GRAHAM (1962, 1981). The Vigo and O Grove specimens which were studied live were whitish, with milk-white, large, irregular spots on the border of the mantle forming groups (Fig. 94). La Atunara (southern Spain) specimens studied preserved in alcohol had orange spots on the mantle border, with opaque translucent white and cream dots all around.

Due to the importance of the penis (Fig. 97) in comparison with other species, it should be described in more detail. It is placed behind the right tentacle and is elongate with a bilobed knob at its apex. These two lobes are different, the larger one being like a spoon, and the smaller one like a finger, with an arrangement similar to a hand with the four fingers fused and forming a concave prolongation, and the thumb in opposition.

The radula (shown in BANDEL, 1984 and FINET, WÜEST AND MAREDA, 1992) (Figs. 83-85, 91) is taenioglossate; rachidian tooth narrow and with a prominent central cusp with 4, sometimes 5, smaller cusps at each side. Lateral teeth with a prominent and wide cusp at the confluence of the internal and the external edges; this cusp may have serrate borders. Internal edge with few wide cusps (usually 4) while the external edge has between 7 and 12. Marginal teeth elongate, curved, sharp pointed and the internal tooth with two borders with few cusps (4-6), while the external one has few cusps (2-4) on its internal part.

The spawn of *C. chinensis* (Figs. 103-105) was studied by LEBOUR (1937), WYATT (1957) and recently described by TRONCOSO, URGORRI AND CRISTOBO (1988) in populations from north-west Spain. It is formed by numerous spherical-ovoid capsules, with a circular section (Figs. 103-104), which are fixed in groups to the substrate by a narrow peduncle (Fig. 105). The development of this species is direct; TRONCOSO *ET AL.* (1988) have shown the intracapsular veliger stage, and here we present two more advanced stages (Figs. 106, 107).

The numerical data in TRONCOSO *ET AL.* (1988) are the following: capsules 1.2-3.0 mm, number of eggs per capsule 2-18 and each egg 0.6-1.0 mm (the reason for this last size is that it refers to two larvae in a capsule). Specimens of 15-20 mm from Vigo and O Grove had 8-15 capsules per spawn, of 10-16 eggs each, 380-490 µm in diameter. From La Atunara, spawn from specimens of 12-17 mm had 8-18 capsules each, with 6-17 eggs each, of 340-430 µm in diameter.



Figures 1-9: *Calyptraea chinensis:* 1-3: Shell, 13.2 mm, Vigo (CER); 4-5: Shell, 13.5 mm, La Atunara, La Línea de la Concepción, Spain (CER); 6: Shell, 8.8 mm, Vigo, Spain; 7-9: Shell, 15.8 mm, St. Brieuc Bay, Bretagne, France (CER).
Figuras 1-9: Calyptraea chinensis*: 1-3: Concha, 13,2 mm, Vigo (CER); 4-5: Concha, 13,5 mm, La Atunara, La Línea de la Concepción, España (CER); 6: Concha, 8,8 mm, Vigo, España; 7-9: Concha, 15,8 mm, St. Brieuc Bay, Bretaña, Francia (CER).*

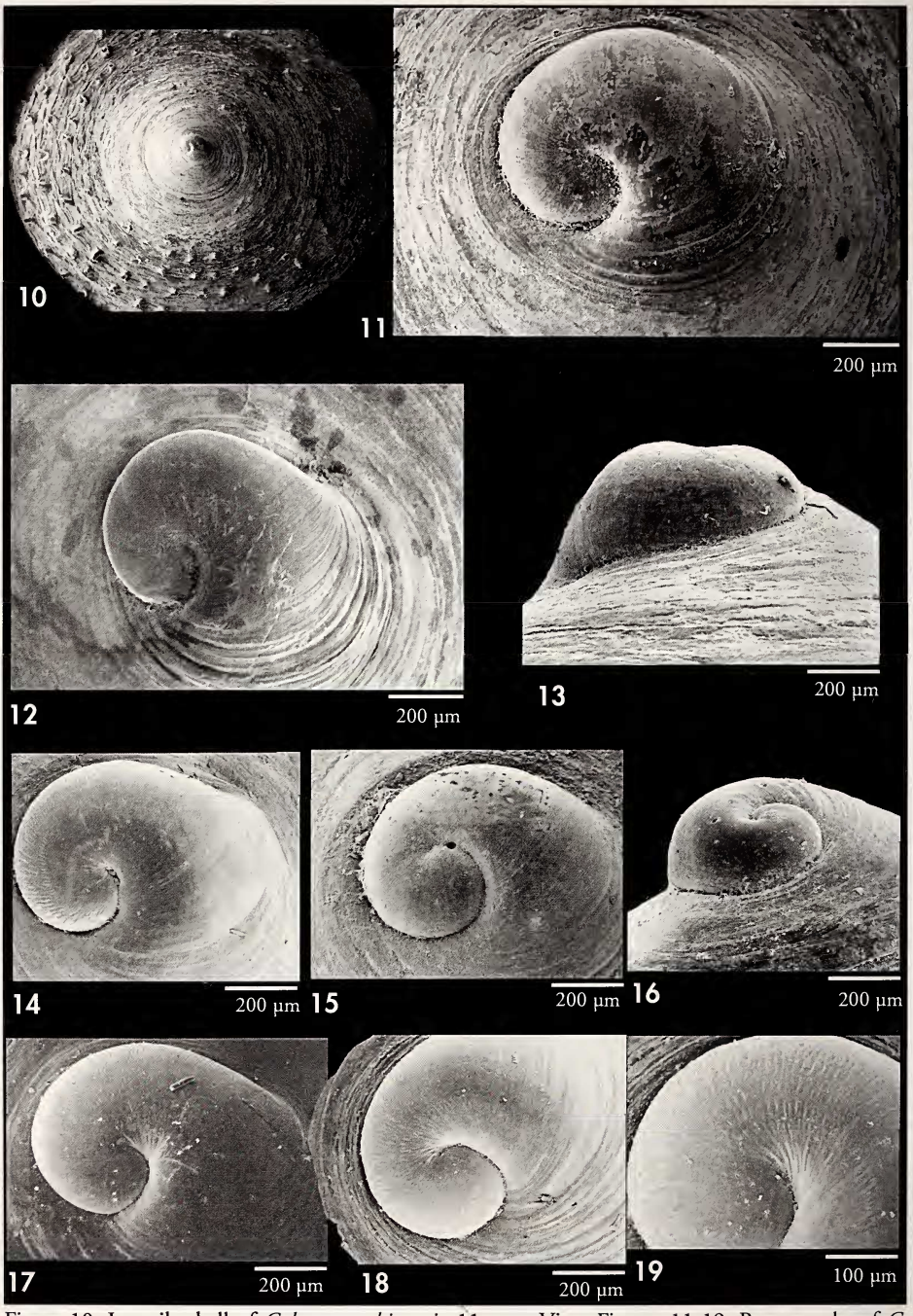
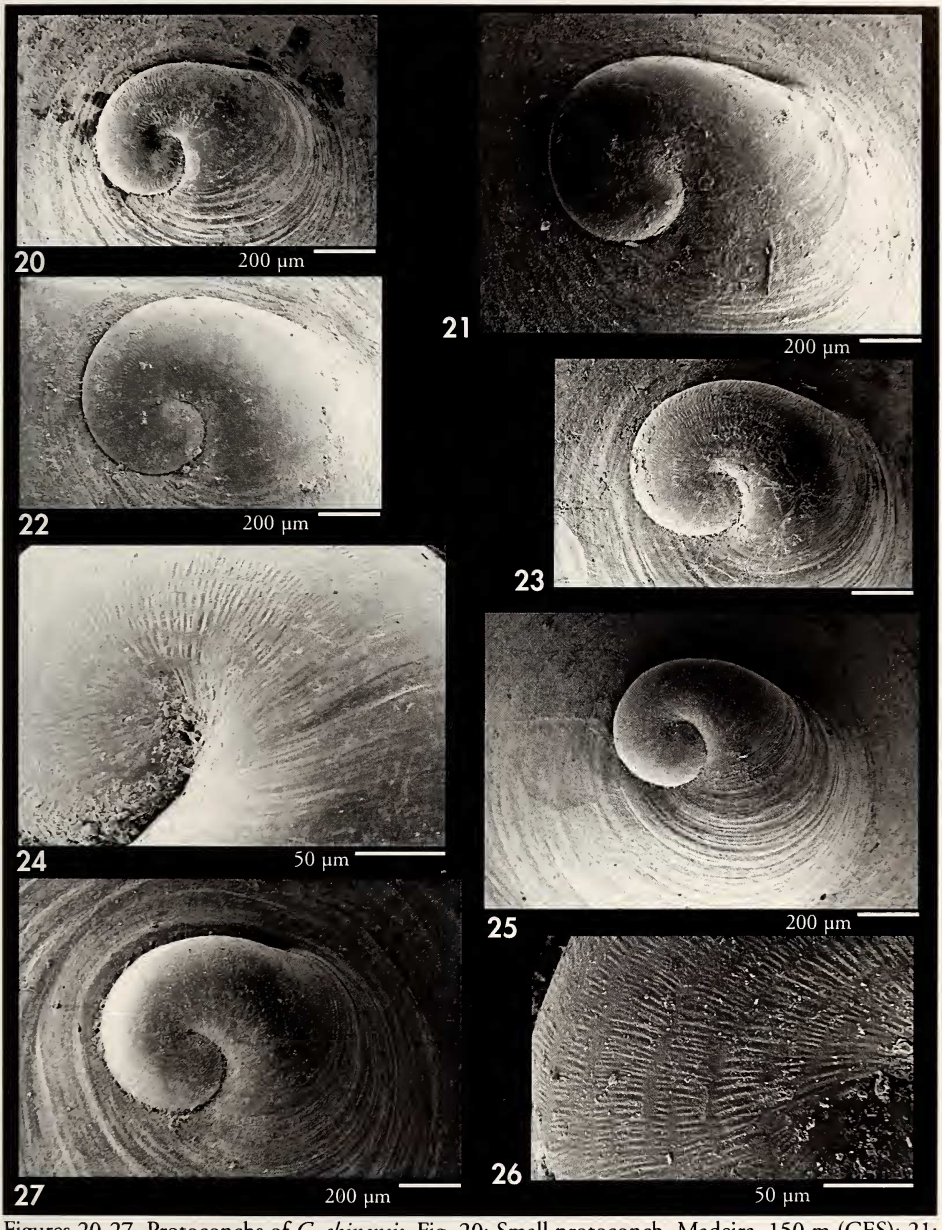
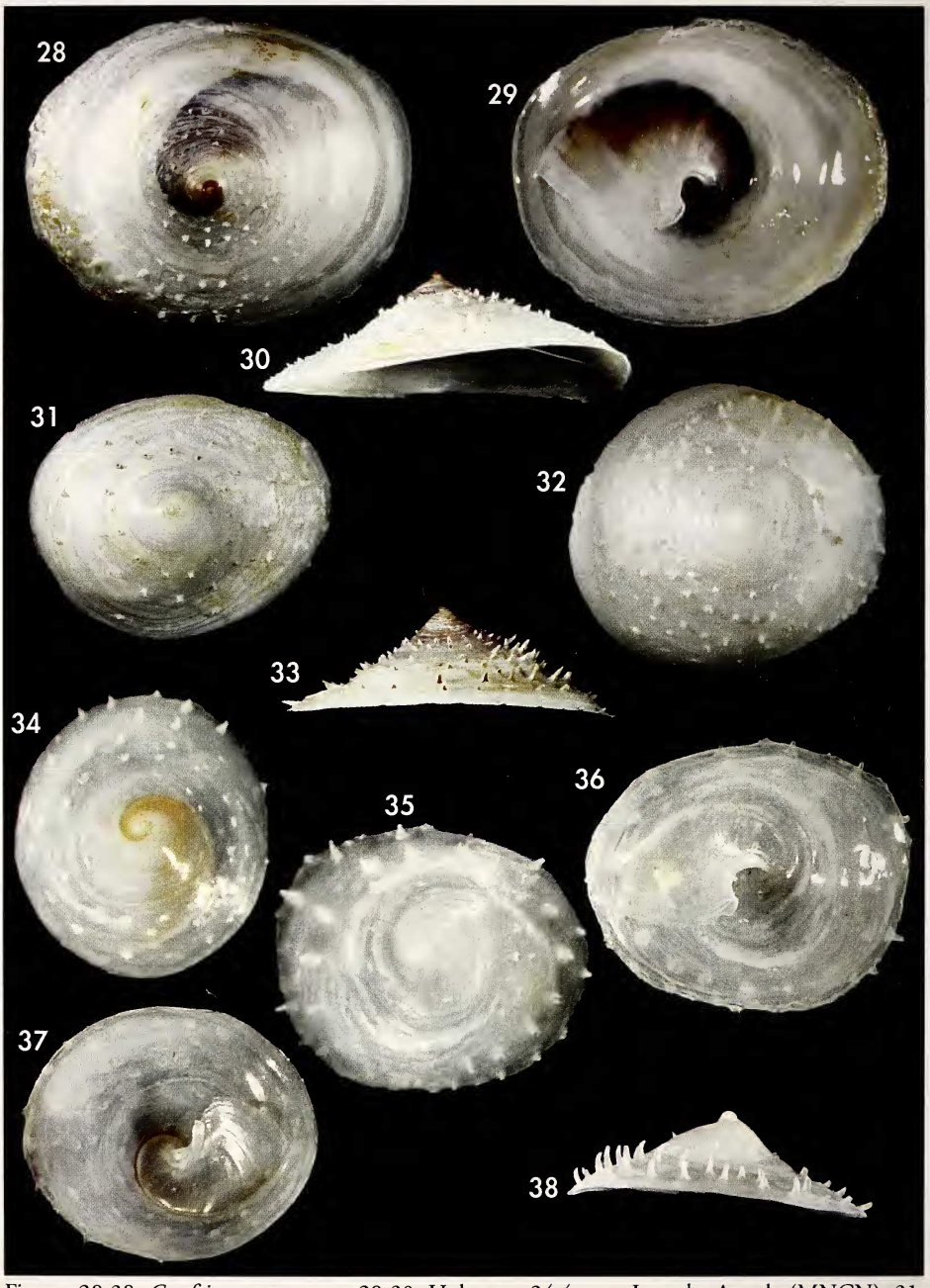


Figure 10. Juvenile shell of *Calyptraea chinensis*, 11 mm, Vigo. Figures 11-19. Protoconchs of *C. chinensis*: 11, 12: Vigo; 13: Bretagne, France; 14: Samil, Vigo; 15, 16: La Atunara, Línea de la Concepción; 17: O Grove; 18: Marbella, Spain; 19: La Atunara.

Figura 10. Concha de un juvenil de Calyptraea chinensis*, 11 mm, Vigo. Figuras 11-19. Protoconchas de* C. chinensis*: 11, 12: Vigo; 13: Bretaña, Francia; 14: Samil, Vigo; 15, 16: La Atunara, Línea de la Concepción; 17: O Grove; 18: Marbella, España; 19: La Atunara.*



Figures 20-27. Protoconchs of *C. chinensis*. Fig. 20: Small protoconch, Madeira, 150 m (CFS); 21: Large protoconch, Funchal, Madeira, 80 m (CFS); 22: Large protoconch, Western Sahara, (CJH); 23: Large protoconch, La Atunara, Spain (CER). 24: Detail of the sculpture of a large protoconch, La Atunara (CER); 25: Small protoconch, Marseille, Tombant, France, 83 m (MNHN); 26: Microsculpture of a small protoconch, Tombant; 27: Large protoconch, Marseille, Tombant, 83 m (MNHN).
Figuras 20-27. Protoconchas de C. chinensis. *Fig. 20: Protoconcha pequeña, Madeira, 150 m (CFS); 21: Protoconcha grande, Funchal, Madeira, 80 m (CFS); 22: Protoconcha grande, Sáhara Occidental, (CJH); 23: Protoconcha grande, La Atunara, España (CER). 24: detalle de la escultura de una protoconcha grande, La Atunara (CER); 25: Protoconcha pequeña, Marsella, Tombant, Francia, 83 m (MNHN); 26: Microescultura de una protoconcha pequeña, Tombant, Francia; 27: Protoconcha grande, Marsella, Tombant, 83 m (MNHN).*



Figures 28-38. *C. africana* spec. nov. 28-30: Holotype, 24.4 mm, Luanda, Angola (MNCN); 31: Shell, 18.4 mm, Palmeirinhas (CER); 32: Shell, 16.6 mm, Nouadhibou, Mauritania; 33: paratype, 18.8 mm, Luanda (MNHN); 34-38: Guinea Conakry, shells (MNHN): 34: 5.0 mm; 35-36: 5.3 mm, 37-38: 5.4 mm.

Figuras 28-38. C. africana *spec. nov. 28-30: Holotipo, 24,4 mm, Luanda, Angola (MNCN); 31: Concha, 18,4 mm, Palmeirinhas (CER); 32: Concha, 16,6 mm, Nouadhibou, Mauritania; 33: Paratipo, 18,8 mm, Luanda (MNHN); 34-38: Guinea Conakry, conchas (MNHN): 34: 5,0 mm; 35-36: 5,3 mm, 37-38: 5,4 mm.*

Distribution: The species is common and widely distributed (see Figure 117) in Atlantic European and Mediterranean areas (Jeffreys, 1882; Locard, 1898); United Kingdom (Jeffreys, 1865; Eales, 1961; Fretter and Graham, 1962, 1981; McMillan, 1973; Seaward, 1985, 1990), Ireland (Minchin, McGrath and Duggan, 1987), France (Bucquoy, Dautzenberg and Dollfus, 1883, Locard, 1892, Dautzenberg and Fischer, 1925; Perrier, 1964; Bouchet, Danrigal and Huyghens, 1978; Finet, Wüest and Mareda, 1992), Belgium (Backeljau, 1986), Spain (Hidalgo, 1917; Rolán, 1993; Rolán and Otero-Schmitt, 1996), Portugal (Nobre, 1940; Macedo, Macedo and Borges, 1999), Mediterranean (Stolfa-Zucchi, 1970; Parenzan, 1970; Sabelli and Spada, 1977, D'Angelo and Gargiullo, 1978; Sabelli *et al.*, 1991; Rinaldi, 1991; Giannuzzi-Savelli *et al.*, 1997; Arduino, Locatelli, Orlando and Repetto, 1995), including the Black Sea (*fide* Fretter and Graham, 1981), North Africa (Pallary, 1900, 1912), Morocco (Pasteur-Humbert, 1962), Canary Is. and Madeira (Nordsieck and García-Talavera, 1979), and for all European coasts (Nordsieck, 1968; Poppe and Goto, 1991). It is not present in the eastern Channel and in the North Sea (Fretter and Graham, 1981). The range is between 24° N and 56° N.

Bathymetrically, *C. chinensis* is frequently a species collected intertidally at low tide, and also circalittoral, with live collected specimens in our material from 190 m. It was recorded by the Porcupine Expedition in 1819 m (Locard, 1898), but only as empty shells.

The records of *C. chinensis* from South Africa (Figs. 78-80) in Barnard (1963), Kensley (1973), Kilburn and Rippey (1982) and Steyn and Lussi (1998) belong to a different species. They will be treated in a further separate paper.

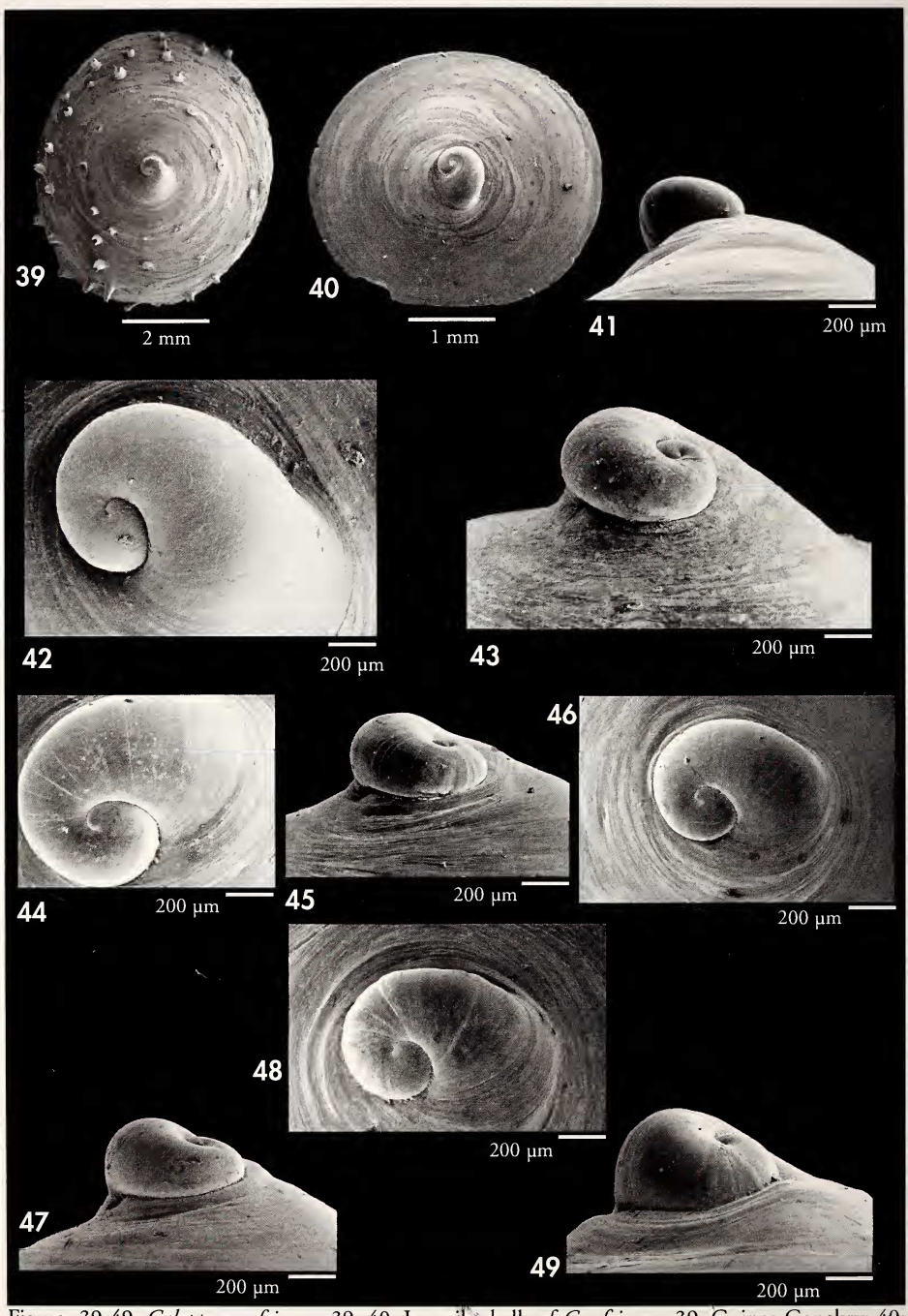
Many other records of *Calyptraea chinensis* from the West African coast correspond to two other different species, which are studied below.

Remarks: The European and north African populations are well represented by the lectotype and paralectotype at LS.

Despite the variability of the species (colour of the shell, presence or absence of spines, size, etc.) the protoconch is relatively constant in size and microsculpture in most of the shells studied. However, out of about two hundred protoconchs examined from La Atunara, seven had a larger size (870-930 µm, Fig. 23). At first it was thought that it could be a different species endemic to the Strait of Gibraltar, but no other differences were found.

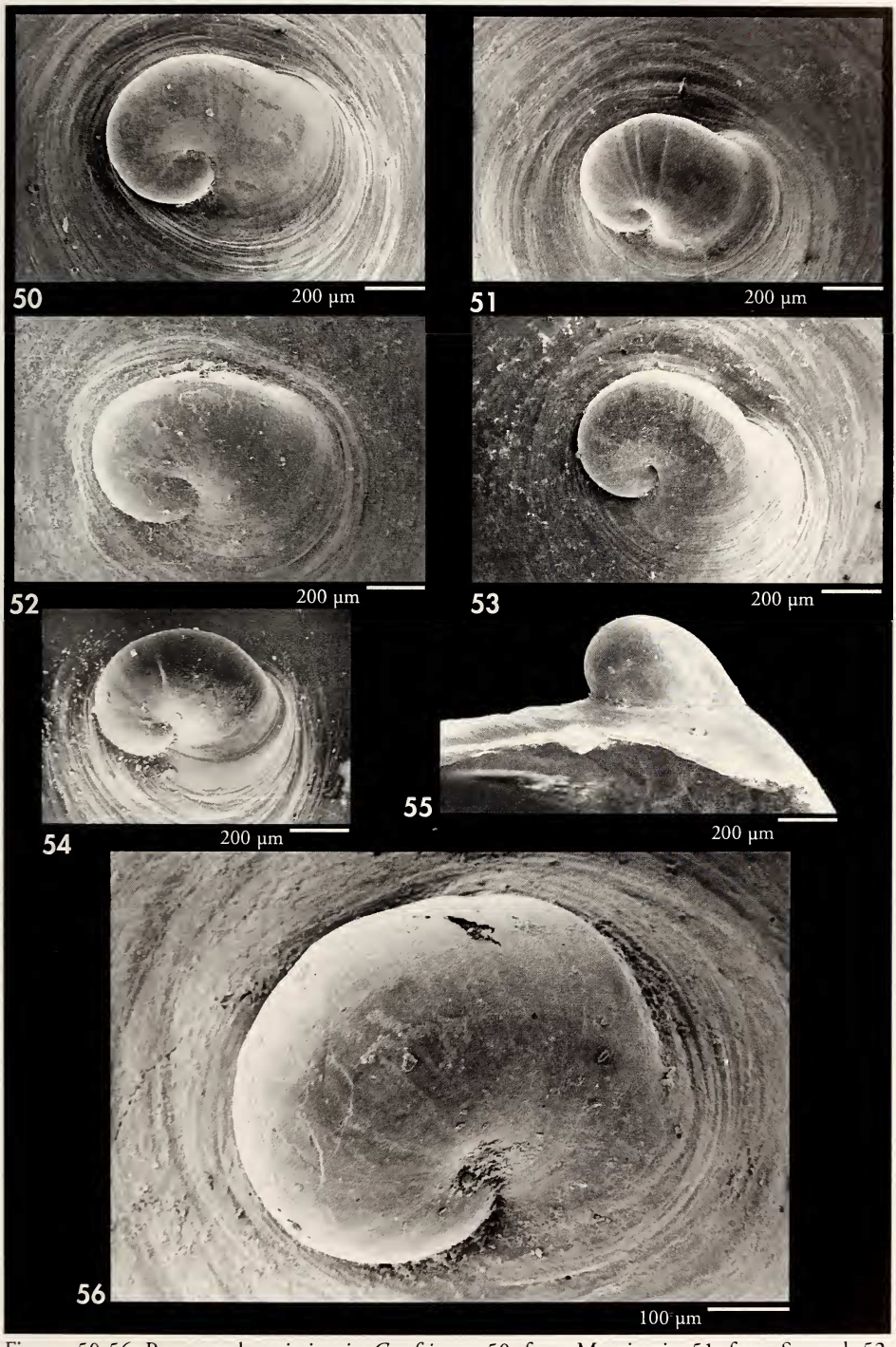
Later, we examined numerous samples from the Canaries and Madeira which had some peculiarities: they were smaller and higher than European and Mediterranean shells and more frequently brown in colour, therefore showing some similarities to *C. inexpectata* (see below). However, the protoconch was similar to those studied from France and Atlantic and Mediterranean Spain, with similar size and sculpture. Some shells of this population with larger protoconchs of almost 1 mm in diameter (Fig. 21 in comparison with Fig. 20) were found. Similarly, some large protoconchs were found in the Western Sahara population (Fig. 22). Finally, in material collected in Tombant, Marseilles, France, *Calyptraea* with both small (Fig. 25) and large (Fig. 27) protoconchs were found. In this case, the few adult shells with large protoconch were also large and very flat (Figs. 75-77), with a width/height ratio of 6.5. This is very unusual, but in considering whether they were conspecific no other differences were found.

We cannot explain why in several populations, some unusual and scarce shells have larger protoconchs which are distinct from natural variation. It is possible that, in this species with intracapsular development, some of the eggs might be used as food by viable larvae. If so, larger protoconchs would be due to greater food availability, and so, increased growth. Troncoso *et al.* (1988) mention that in a capsule with only two eggs, the size of both larvae was of 1 mm, while in another capsule



Figures 39-49: *Calyptraea africana*. 39, 40: Juvenile shells of *C. africana*; 39: Guinea Conakry; 40: Ivory Coast. Figures 41-49: Protoconchs: 41: Guinea Conakry; 42, 43: Angola; 44, 45: Ghana: 46, 47: Ivory Coast; 48, 49: Banc d'Arguin, Mauritania.

Figuras 39-49: Calyptraea africana. *39, 40: Conchas juveniles de* C. africana*; 39: Guinea Conakry; 40: Costa de Marfil. Figuras 41-49: Protoconchas: 41: Guinea Conakry; 42, 43: Angola; 44, 45: Ghana: 46, 47: Costa de Marfil; 48, 49: Banc d'Arguin, Mauritania.*



Figures 50-56. Protoconch variation in *C. africana*: 50: from Mauritania; 51: from Senegal; 52, 53: from Guinea Conakry; 54-56: from Principe.
Figuras 50-56. Variación en la protoconcha de C. africana*: 50: de Mauritania; 51: de Senegal; 52, 53: de Guinea Conakry; 54-56: de Príncipe.*

with 18 larvae, the average size was 0.6 mm.

These larger protoconchs were not found in the populations examined from Galicia, Spain and Bretagne, France.

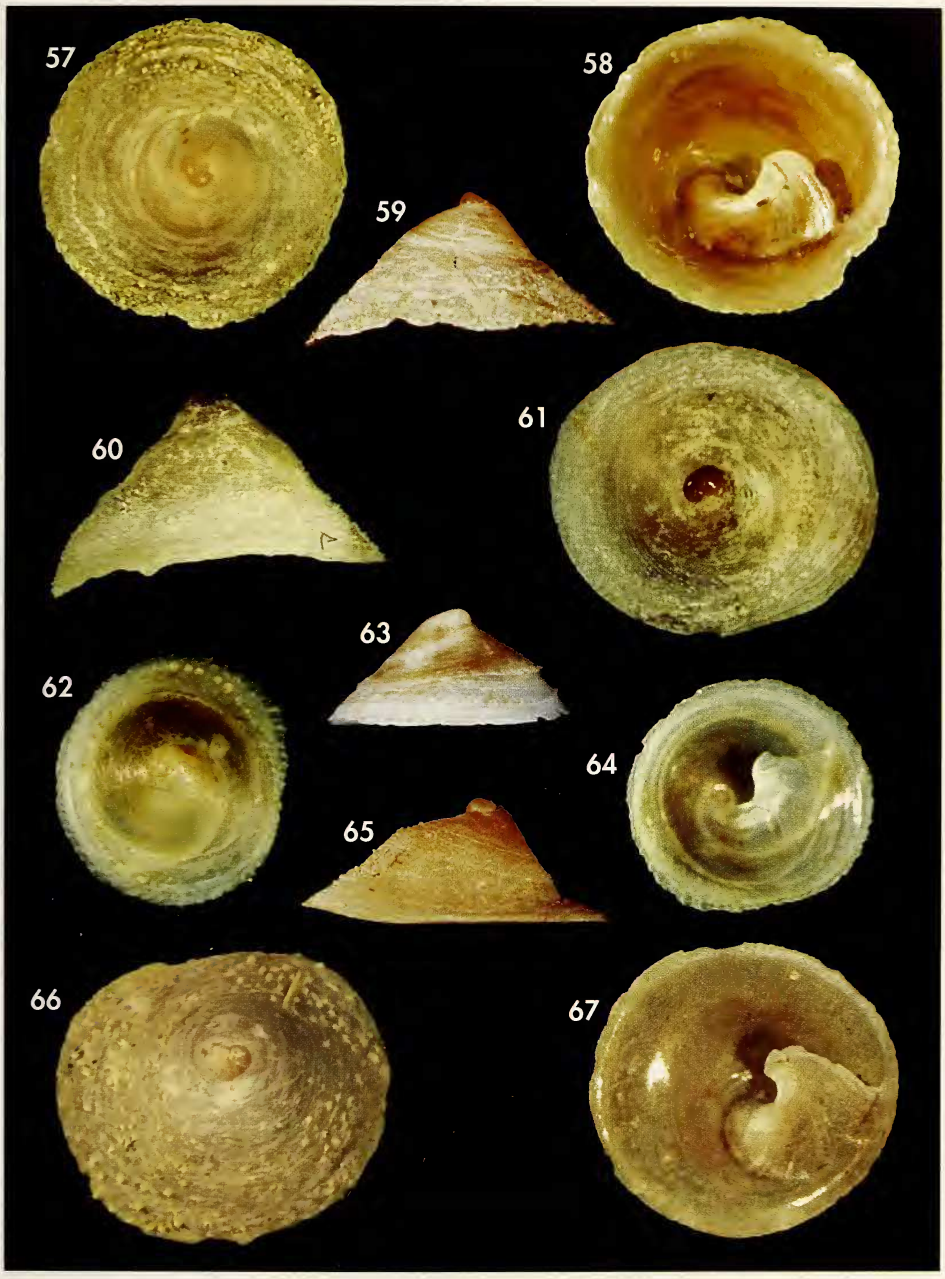
A strange shell of *Calyptraea* (Figs. 81, 82) was collected in La Palma, Canary Islands. It seems to be very different from *C. chinensis*, but it could be introduced material from ships.

Calyptraea africana spec. nov. (Figs. 28-56, 86-88, 92, 95, 98, 101, 108-112)

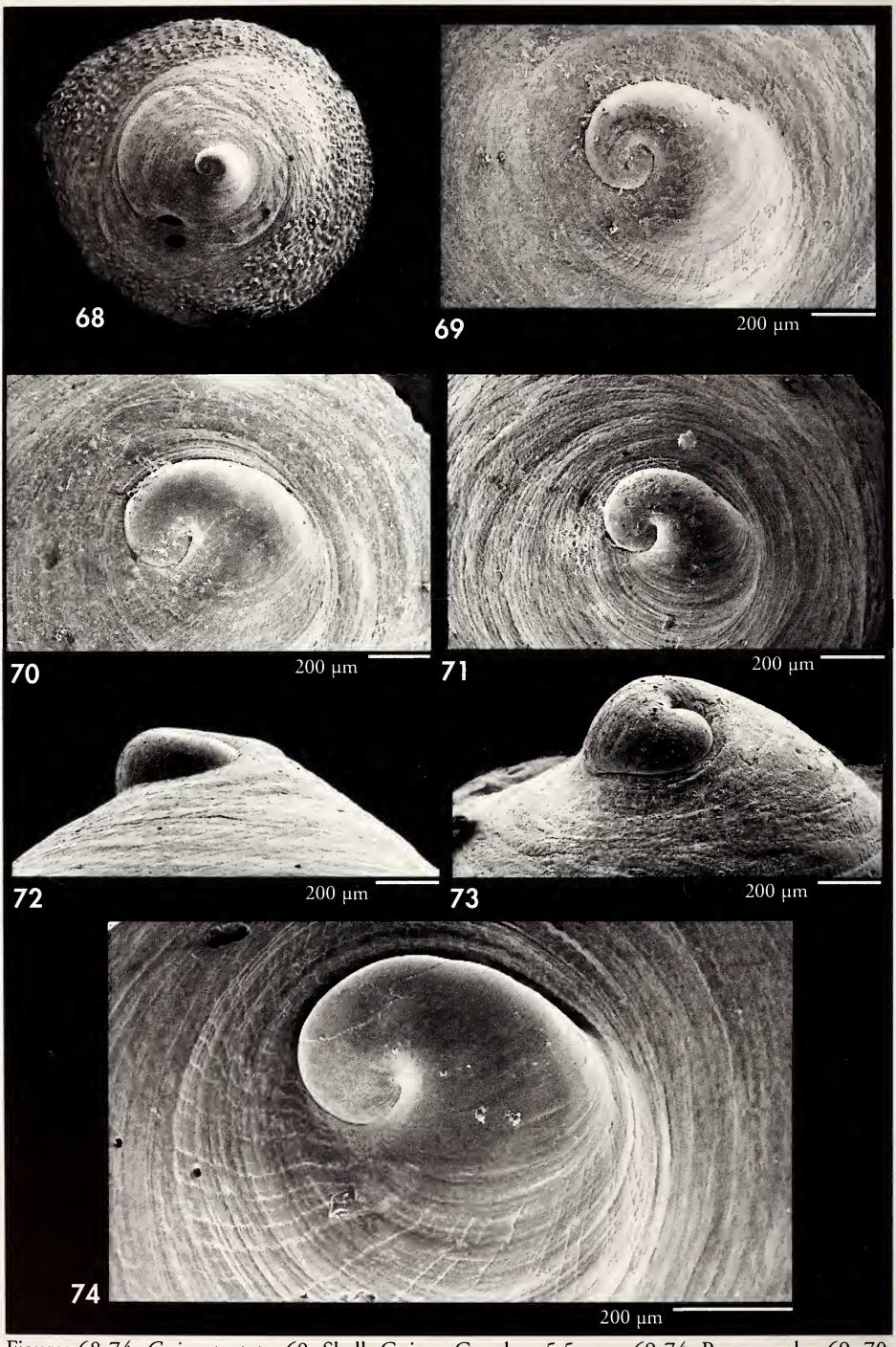
Calyptraea chinensis auct. (non Linnaeus, 1758).
? Calyptraea solida von Martens, 1874 (non Reeve).

Type material: Holotype (Figs. 28-30) in MNCN (15.05/46621); Paratypes in the following collections: MNHN (1), AMNH (1), BMNH (1), ZSM (1), CER (30), CJH (1), CFS (1), all from Luanda (Angola).

Other material studied: Western Sahara: 17 s, Port Etienne, Mission Gruvel (MNHN). Mauritania: 12 sp, 3 miles W Kiaone 20° 02' N 16° 22' W, 6 m (MNHN); 6 s, 20° 10' N 16° 30' W, 16 m (MNHN); 15 sp, 2 s, 20° 20' N 16° 22' W, 10 m (MNHN); 15 c, Cansado Bay, Mission Gruvel (MNHN); 2 sp, 5 s, Nouadibhou, dredged 3 m (CER); 3 s, Baie de l' Etoile, dredged in front Club Nautique, 4 m (CER); 155 s, 25 j, Banc d' Arguin, intertidal sediments (CER). Senegal: 2 c, Salin La Ventite (CFS); 12 c, Thiaroye NNE Dakar, 7-8 m (MNHN); 1 c, N Cayar, 15° 12' 5"N 15° 54' 8"W, 25 m (MNHN); 126 s, 178 j, between Dakar and Gorée, dredging 20-40 m (CER); 3 s, Casamance, 12° 20.7' N 16° 53.1' W, 15 m,R/V "Louis Sauger" (MNHN); 1 s, 2 j, Cap Vert, Epave, 15 m (CER); 4 sp, M' Bao, Dakar, 9-10 m (MNHN); 1 sp, 89 s, Almadies, Dakar, 20 m, on shells in sandy bottom (CER); 18 s, Dakar (MNHN); 2 j, Tacoma, 25 m (MNHN); 2 c, N Casamance 12° 53.8' N 17° 03.5' W, 19 m (MNHN); 3 sp, Region de Sine-Saloum, mangroves (MNHN); 3 c, N Casamance, Kafountine 12° 54.4' N 17° 01.5' W, 17 m (MNHN); 17 sp, N Casamance 12° 50.4' N 16° 58.8' W, 13-14 m (MNHN); 5 sp 4 s, Casamance, Zinguinchor, 3-5 m (MNHN); 17 s, S Casamance, frontier of Guinea Bissau, 4-6 m (MNHN); 1 s, Carabane Bôlon, 3-4 m (MNHN); 3 c, S Casamance, Cap Skirring, in beach sediment (MNHN). Guinea Bissau: 10 sp, Essoukkoundiak Bôlon, near frontier, 5-6 m (MNHN); 2 s, Bissagos Is., Mission L. Gain (MNHN). Guinea Conakry: 60 sp, 6 s, W Ile Knebomby N/O "André Nizery" Sedigui I, Sta. 376, 5 m, 9° 48' N 13° 53' W (MNHN); 12 s, W Ile Knebomby N/O "André Nizery" Sedigui I, Sta. 376, 5 m, 9° 48' N 13° 53' W (MNHN); 36 s, W Kaporo N/O "André Nizery" Sedigui I, Sta. 270, 6 m, 9° 36' N 13° 38' W (MNHN); 3 j, W Ile Quito, N/O "André Nizery" Sedigui II, Sta. 515, 26 m, 10° 00' N 15° 43' W (MNHN); 2 c, NW Ile Tamara, N/O "André Nizery" Sedigui I, Sta. 265, 10 m (MNHN); 2 j, SW Ile Tamara, N/O "André Nizery" Chalgui 7, Tr. 17, 18 m, 9° 28' N 13° 53' W (MNHN); 3 j, W Yomponi river N/O "André Nizery" Sedigui II, Sta. 724, 21 m, 10° 24' N 15° 21' W (MNHN); 12 j, frontier Sierra Leona, N/O "André Nizery" Chalgui 7, Tr. 6, 12 m, 9° 01' N 13° 30' W (MNHN); 1 s, W Kaporo N/O "André Nizery" Sedigui I, Sta. 276, 18 m, 9° 36' N 14° 06' W (MNHN); 2 s, W Kaporo N/O "André Nizery" Sedigui I, Sta. 275, 16 m, 9° 36' N 14° 03' W (MNHN); 26 s, W Morébaya river N/O "André Nizery" Sedigui I, Sta. 168, 12 m 9° 24' N 13° 38' W (MNHN); 5 s, 9° 40' N 14° 05' W 18 m (MNHN). Ivory Coast: 1 sp, 120 s, 6 j, Radiale Grand Bassam N/O Antéa Benchaci I, Sta. 12D, 30 m 5° 09.2' N 3° 47.2' W (MNHN); 1 s, Batrevie Beach, Sassandra (MNHN); 1 c, Abidjan (MNHN). Ghana: 52 sp, 22 s, 65 j, off Miamia, 30 m, on shell, in sandy and rocky bottom (CER). Cameroun: 1 s, Wouri Cap Nachtigal 03° 44' N 09° 22' E, 13 m (MNHN); 1 s, Wouri Cap Nachtigal 03° 37' N 09° 16' E, 40 m (MNHN); 1 sp, Victoria/Limbé, Bota, 8-10 m (MNHN). São Tomé and Principe: 1 c, Baia de Ana Chaves (MNHN); 63 s, Principe, "Calypso", 15-18 m (MNHN); 12 s, Santo Antonio, Principe, 10 m, on sandy sediments (CER). Gabon: 2 s, Cap Esterias-Pointe Idolo (MNHN); 2 s, Cap Esterias, Libreville (MNHN). Congo: 1 sp, 12 s, 12 j, Pointe Noire, Mondaine beach, 1-5 m (MNHN); 4 j, Conkouati, chalutier "Kounda", 17-19 m (MNHN); 28 sp, 10 s, Orstom Beach, Pointe Noire, 3-7 m (MNHN); 1 sp, Pointe Noire, Songolo, 6 m (MNHN). Angola: 1 sp, Cabo Ledo, Luanda, 10-40 m (MNHN); 39 sp, Corimba, Luanda, 20 m, on shells in rocky bottom (CER); 3 s, Corimba, Luanda, 10-20 m (MNHN); 10 s, Cacuaco, Bengo, 10-40 m (CFS); 4 sp, 3 s, Cacuaco, Bengo, 7 m, on shells in muddy bottom (CER); 1 s, Praia Etambar, beach sedimen (MNHN); 4 sp, 1 s, Cacuaco, Bengo, infralittoral rocks (MNHN); 6 sp, 1 s, Samba, Luanda, 2 m, on shells in sandy bottom (CER); 4 sp, Samba, intertidal (CER); 5 sp, Palmeirinhas, 15-20 m, on shells



Figures 57-64. *Calyptraea inexpectata.* 57-59: Holotype, 5.3 mm, Ile de Los, Guinea Conakry, 35 m (MNHN); 60, 61: Shell, Western Sahara, 5.8 mm (CJH); 62-64: Shell, Western Sahara, 4 mm (CJH). Figures 65-67. *Calyptraea chinensis,* form similar to *C. inexpectata*: 65: shell, 6.1 mm, Caja de Lazareto, Madeira, 60 m (CFS); 66, 67: Shell, 5.8 mm, Caja de Lazareto, Madeira (CFS).
Figuras 57-64. Calyptraea inexpectata. *57-59: Holotipo, 5,3 mm, Ile de Los, Guinea Conakry, 35 m (MNHN); 60, 61: Concha, Sáhara Occidental, 5,8 mm (CJH); 62-64: Concha, Sáhara Occidental, 4,0 mm (CJH). Figuras 65-67.* Calyptraea chinensis, *forma similar a* C. inexpectata*: 65: concha, 6,1 mm, Caja de Lazareto, Madeira, 60 m (CFS); 66, 67: Concha, 5,8 mm, Caja de Lazareto, Madeira (CFS).*



Figures 68-74: *C. inexpectata.* 68: Shell, Guinea Conakry, 5.5 mm; 69-74: Protoconchs; 69, 70: From Guinea Conakry; 71: Senegal; 72: Guinea Conakry; 73: Senegal; 74: Guinea Conakry.
Figuras 68-74: C. inexpectata. *68: Concha, Guinea Conakry, 5,5 mm; 69-74: Protoconchas; 69, 70: Guinea Conakry; 71: Senegal; 72: Guinea Conakry; 73: Senegal; 74: Guinea Conakry.*

in rocky bottom (CER); 15 s, off Luanda, 50 m, in sandy sediments (CER); 40 sp, 20 s, Mussulo, Luanda, 10-20 m (MNHN); 1 j, Lobito, intertidal (CER); 8 sp, San Antonio, Benguela, 5-10 m (MNHN); 4 s, Praia Santiago, Bengo, beach sediment (MNHN); 1 c, Mossamedes Bay, 5-10 m (MNHN);
Type locality: Luanda, Angola.
Etymology: The specific name derived from the African coasts where the species was collected.

Description: Shell (Figs. 28-40) with a patelliform shape and usually ovoid at its base (circular only in juveniles), rather fragile, transparent, smooth and shiny. It has an elevated apex, but usually the profile of the shell appears to be slightly concave, and the shell is rather depressed. Width/height ratio is about 3.3-4.5.

The protoconch may have two different forms. The first one (Figs. 40-49) has approximately 1 and 1/4 whorls, with a very small nucleus which is usually 60 to 100 µm in diameter. The protoconch diameter increases quickly, to reach 10/12 times the size of the nucleus at the end. The total diameter of the protoconch is difficult to measure because the protoconch-teleoconch boundary is not evident, but may have between 700-900 µm. Seeing this protoconch laterally, we normally find that the periphery is more prominent than the teleoconch on which it is placed, resulting in a deep suture (Figs. 41, 43, 45). The second type of protoconch (Figs. 50-56) has only 1 whorl and a larger nucleus (85-157 µm) and the rate of whorl expansion is smaller (at the end the diameter of the whorl is 3-8 times that of the nucleus) and the total diameter of the protoconch is between 500-750 µm. There are no clear intergradations between these two types of protoconchs.

The teleoconch is smooth, glossy, transparent; most of the shells have sparse widely separated elevated spicules, which are not usually present in a short circle around the apex. These spicules (Figs. 28, 33-35, 38, 39, 101) are variable from one shell to another, more common in some populations and rare in others. Internally the shell is glossy.

The colour of the shell is transparent whitish. The apex is sometimes yellowish, or even dark brown, and this colour may extend along the suture; occasional shells may be almost entirely light brown. Aperture ovoid with the peristome usually at one level but sometimes curved to match the surface to which it is applied. Internally, a partition arises from the shell along a curved line running from the apex to near the aperture posteriorly.

Dimensions: Variable between populations: shells from Mauritania to Ivory Coast sometimes reach 20 mm in maximum diameter, but one exceptional shell from Dakar (MNHN) was 28.5 mm; in comparison, specimens from Angola are usually larger, about 25 mm in diameter, but can reach 28-32 mm, with a record of 35.0 mm.

Animal (described from Ghana specimens) (Fig. 95) with a rounded foot, which has two pointed extremes on the anterior border; the sole, seen with magnification, has many very small violet spots which give this tone to the whole; the head is elongate posterior to the tentacles, the snout being rather short and broad; the tentacles, milk white at the centre, sometimes with dark lines at the external border; eyes near the base in a posterior widening; the mantle has very numerous and small milk-white dots, which are grouped irregularly forming variable blotches. The penis (Fig. 98) (examined in some males of 5 mm) is bilobed at its extreme, one of the lobes being formed by two masses together; a narrow worm-like filament is present near the tip. In living males, the penis is bent dorsally towards the posterior part of the animal; the females have in this place an atrophied stub.

Seen dorsally, by transparency, a dark intestinal tract can be observed surrounding the apex which curving to the left and returning parallel to the right side. Some Angolan specimens observed live also fit this description.

Radula (Figs. 86-88, 92) with a narrow rachidian tooth with a not very prominent central cusp and up to 12

Figures 75-77. *Calyptraea* cf. *chinensis*, 17.0 x 2.6 mm, Tombant, Est du Grand Congloué, Marseille, 83 m (MNHN). Figures 78-80. *Calyptraea* aff. *chinensis*, South Africa, 19.4 y 20.2 mm (CER). Figures 81, 82. *Calyptraea* sp., La Palma, Canary Ids., 11.1 mm (CER).
Figuras 75-77. Calyptraea *cf.* chinensis, *17,0 x 2,6 mm, Tombant, Est du Grand Congloué, Marseille, 83 m (MNHN). Figuras 78-80.* Calyptraea *aff.* chinensis, *África del Sur, 19,4 y 20,2 mm (CER). Figuras 81, 82.* Calyptraea *sp., La Palma, Canarias, 11,1 mm (CER).*

Figures 83-90. Radulae of *Calyptraea*. 83: *C. chinensis*, O Grove, specimen of 12.4 mm; 84, 85: *C. chinensis* La Atunara, Línea de la Concepción, shell of 13.4 mm; 86-88: C. *africana*, Guinea Conakry, shell of 10.0 mm; 89-90: C. *inexpectata*, Tacoma, Dakar, shell of 12.0 mm.
Figuras 83-90. Rádulas de Calyptraea. *83:* C. chinensis, *O Grove, ejemplar de 12,4 mm; 84, 85:* C. chinensis *La Atunara, Línea de la Concepción, concha de 13,4 mm; 86-88:* C. africana, *Guinea Conakry, concha de 10,0 mm; 89-90:* C. inexpectata, *Tacoma, Dakar, concha de 12,0 mm.*

smaller cusps on each side. Lateral tooth slightly prominent and with a narrow cusp in the confluence of the internal and the external edges; internal edge with numerous and irregular cusps (usually up to 11), while the external edge has more numerous cusps (22-30). Marginal teeth elongate, curved, sharply pointed; the internal with two borders with up to 20 cusps on the internal border and less on the external (4-6), while the external teeth have up to 15 cusps on its internal part.

The spawn is formed by numerous ovoid elongate capsules (Fig. 108-111) which are fixed to the substrate and sat upon by the animal. On some occasions, when the animal was removed from the substrate, some capsules remained around the foot (Fig. 110). In the larger Angolan specimens, the spawn was composed of up to 48 capsules, with 57/90 eggs in each. In the case of a small specimen of 12 mm, there were 18 capsules with 13 - 35 eggs of 170-260 µm diameter. In Ghana specimens, animals between 8-13 mm had 17-26 capsules/each and between 10-30 eggs per capsule, with an average egg diameter of 166 µm. At hatching, the shells already have the juvenile morphology (Fig. 112).

Distribution: The shells mentioned as *Calyptraea chinensis* from West Africa or from countries in this area are probably best referred to the present species: DAUTZENBERG (1912), KNUDSEN (1950) and NICKLÉS (1950) recorded it in several localities; NICKLÉS (1947) also for Senegal; LAMY (1923) for Bissagos Islands; BUCHANAN (1954) for Ghana; TOMLIN (1923) and FERNANDES AND ROLÁN (1993) for São Tomé and Principe; BERNARD (1984) for Gabon; COLLINGTON (1960) for Congo; GOFAS, AFONSO AND BRANDÃO (1985) and ROLÁN AND RYALL (1999) for Angola.

In our material, the species is represented by shells and specimens collected from south of Western Sahara/Mauritania (21.5° N) down to Angola (15° S), including the Gulf of Guinea islands of São Tomé and Principe (Fig. 117). It was not collected in the Cape Verde Islands or in Annobon.

This species usually occurs in shallow water. The deepest live-collected specimens from the Ghana area are from 20-30 m, but are usually found in shallower waters in Mauritania, Senegal, Guinea Conakry and Angola.

Discussion: The new species *C. africana* differs from *C. chinensis* in numerous characters (Table I). The most important are: *C. chinensis* is usually smaller, more rounded in form and rarely appearing ovoid; the shell is more solid at a similar size, not transparent, more variable in colour and the external surface is not glossy; the projections on the external surface, when they are present, are denser and not very prominent; the protoconch has a larger nucleus, larger spire ($1\ ^1/_4$ versus $^3/_4$ - 1), spiral rows of micro-undulations, and seen from the side the protoconch is more distinct from the teleoconch by a deeper suture. The penis is also different, *C. chinensis* has an elongate penis expanded into two lobes at its apex like a spoon with a thumb in opposition, while *C. africana* is bilobed and has on one side two masses together and a narrow filament. The spawns are also different, with capsules more elongate in *C. africana* and more spherical sometimes slightly ovoid in *C. chinensis*; the eggs are smaller in *C. africana* than in *C. chinensis*.

KNUDSEN (1950) probably examined the spawn of *C. africana* because one of the populations mentioned was collected at 17 m, in the middle of the distribution of this species. The other two populations were probably from a different species because *C. africana* has not been collected alive at 34-50 m.

The presence of two kinds of protoconchs with different characters without intergradations made us suspect that we could be working with two different species. This could correspond to two sympatric sibling species. Furthermore, the most common type of protoconch, the larger one, is the only form observed in Angolan populations; the smaller one appears more frequently in the Principe population and also in shells from Ghana, Ivory Coast, Guinea Conakry and Senegal, but is always present in

Table I. Differences in characters of the shell, protoconch, radula and spawn of *Calyptraea chinensis, C. africana* spec. nov. and *C. inexpectata* spec. nov.
Tabla I. Diferencias entre los caracteres de la concha, protoconcha, rádula y puesta de Calyptraea chinensis, C. africana *spec. nov. y* C. inexpectata *spec. nov.*

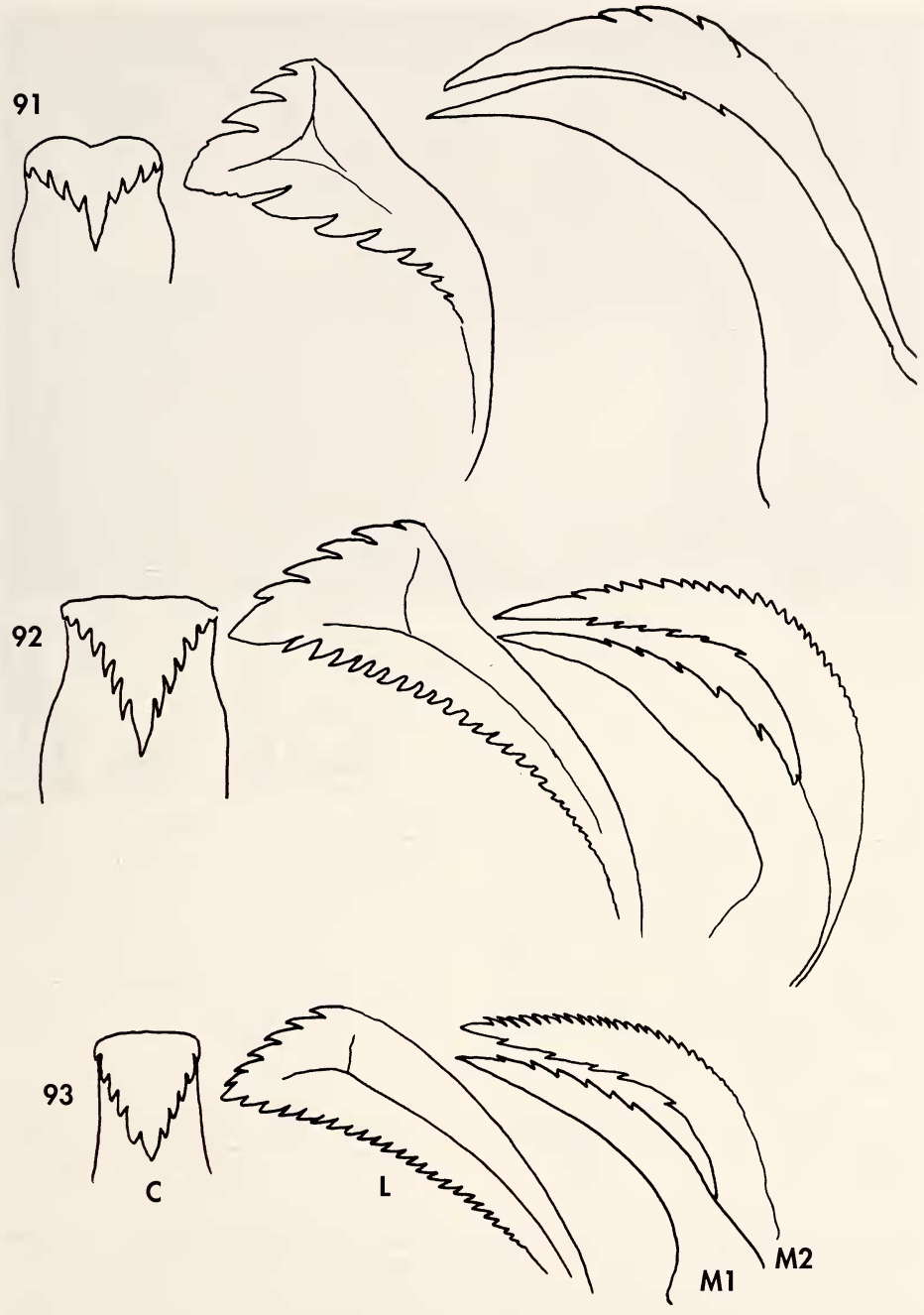
	C. chinensis	*C. africana* spec. nov.	*C. inexpectata* spec. nov.
Profile of the shell	hooked	tendency to be concave	tendency to be convex
Form of the aperture	rounded	ovoid in adult	rounded irregularly
Border of the shell aperture	uniform	uniform	frequently undulate or irregular
Transparency of the shell	no	yes	no
Shell width / height ratio	2.5-3.1	3.3-4.5	1.8-2.4
Most common coloration	white	white or white with the apex yellowish or brown	totally white or brown
Other possible colorations	pink, brown, violet	subsutural brown band	apical brown
External sculpture	usually smooth, sometimes with numerous prominences	usually smooth, sometimes with very elevated and separate prominences	sometimes wrinkled, frequently numerous scarcely elevated prominences like scales
Usual shell diameter	up to 15 mm	up to 25 mm	up to 7.5 mm
Maximum diameter	25.0 mm	35.0 mm	12.0 mm
Protoconch: diameter	600-741 µm	form 1: 700-900 µm form 2: 500-750 µm	471-614 µm
Protoconch: diameter of the nucleus	194-230 µm	form 1: 60-100 µm form 2: 85-157 µm	142-215 µm
Protoconch: number of whorls	3/4 - 1	form 1: 1 1/4 form 2: 1	1
Diameter nucleus/diameter at the end of the protoconch ratio	3-3.5	form 1: 10-12 form 2: 3-8	2.7-4.5
Elevation of the protoconch from the teleoconch	slightly elevated and suture not deep	elevated with deep suture	slightly elevated and suture not deep
Protoconch sculpture	spiral bands of axial striae	no	no
Sculpture at the beginning of teleoconch	no	no	spiral grooves
Spawn: capsules	spherical scarcely ovoid	ovoid	unknown
Eggs size	340-490 µm	160-270 µm	unknown
Animal mantle	transparent with some white spots grouped in the border	transparent with irregular white spots	transparent with very evident radiating milk white lines at the border
Penis	bilobed with distally a opposing thumb on a spoon	bilobed like two fused eggs, with other prominence and a fine worm like filamente	elongate, straight, with two angulations
Depth limits of the live collected specimens	0 – 190 m	3 – 30 m	25-53 m

small numbers (about 10%). For this reason, we undertook a detailed study to find other differences which can usually be found in two sibling species. In the present case, the comparison of animals, shell characters, radula, etc. did not show other differences and it was not possible to prove that these different protoconchs were the result of sampling two species. For the time being we decided to consider the shells with these two kinds of protoconchs as conspecific. The holotype is a shell with the large type of protoconch, from Luanda, Angola, an area where the second type of protoconch has never been found. Currently there is no explanation for this difference, and it is expected that the future study of DNA will provide additional information.

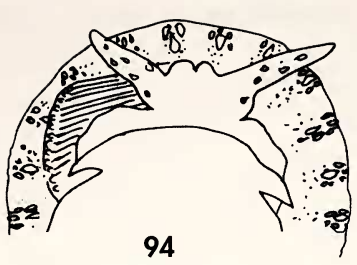
Calyptraea inexpectata spec. nov. (Figs. 57-74, 68-74, 89, 90, 93, 96, 99, 102)

Type material: Holotype (Figs. 57-59) deposited in MNHN with 1 paratype from type locality; 10 paratypes more, from W Kaporo, Sta. 275, 16 m, 9° 36′ N 14° 03′ W; 2 more from W Pte. Goro, Sta. 544, 41 m, and 1 more from W Cap Verga, Sta. B5CH, 20 m, 10° 12′ N 13° 06′ W, all them from N/O "André Nizery" Sedigui I and II. Other paratypes, from 40 m between Dakar and Gorée, in the following collections: MNCN (15.05/46622) (1), AMNH (1), BMNH (1), ZSM (1), CER (68), CJH (1), CFS (1).
Other material examined: Western Sahara: 2 s, 23° 05′ N 16° 00′ W, 27-36 m (CJH); 1 sp, (CJH); 1 s, 22° 35′ N 16° 58′ W, 86 m (CJH); 2 s, 23° 05′ N 16° 00′ W, 25-50 m, (CJH); 1 sp, (CJH); 3 s, 22° 35′ N 16° 58′ W, 86 m (CJH). Mauritania: 1 s, 17° 42′ N 16° 12′ W, 46 fms, (CJH); 8 s, 17° 22′ N 16° 17′ W, dredged at 70-100 m (CJH); 2 s, (MNHN); 1 s, N/O N′ Diago 18° 12′ N 16° 20′ N, 50 m (MNHN); 1 s, N/O N′ Diago 19° 12′ N 16° 40′ N, 47 m (MNHN); 3 s, N/O N′ Diago 19° 06′ N 16° 34′ N, 37 m (MNHN); 1 s, N/O N′ Diago 17° 42′ N 16° 25′ N, 50 m (MNHN); 4 s, N/O N′ Diago 17° 18′ N 16° 26′ N, 76 m (MNHN); 1 s, N/O N′ Diago 17° 36′ N 16° 23′ N, 65 m (MNHN); 1 s, N/O N′ Diago 19° 00′ N 16° 30′ N, 31 m (MNHN); 1 c, 17° 17′ N 16° 30′ W, 85 m (MNHN); 1 s, 17° 45′ N 16° 23′ W, 300-600 m (CFS). Senegal: 1 sp, 12 s, Tacoma, 25 m (CER); 2 s, 3 j, Cap Vert, Epave, 15 m (CER); 5 sp, 225 s, SW Ile Madeleine, Dakar, 48 m (MNHN); 3 j, SW Madeleines, Dakar, 455-465 m (MNHN); 4 c, Dakar 14° 23′ 5″N 17° 24′ 5″W, 65-70 m (MNHN); 53 s, Gorée, 20 m (CFS); 3 sp, dredged near Gorèe, 15-25 m (CER); 20 s, S Gorée, Dakar, 33-42 m (MNHN); 16 s, 6 j, S Gorée, 98 m (MNHN); 6 s, Dakar 14° 27′ N 17° 33′ W, 145-200 m (MNHN); 13 j, Dakar, 6 m (CER); 8 s, 8 j, Dakar, 20 m (CER); 15 s, E Gorée, 20 m (MNHN); 49 s, S Gorée, "G. Treca", 65 m (MNHN); 1 sp, 14 s, 8 j, Tacoma, 20-25 m (CER); 5 s, Delta of Saloum, (CJH); 1 sp, N Casamance 13° 01.8′ N 17° 25.5′ N "Louis Sauger", 53 m (MNHN); 1 s, Casamance, 12° 20,7′ N 16° 53.1′ W, R/V "Louis Sauger", 15 m (MNHN); 2 s, N Casamance 12° 32′ N 17° 28.8′ N "Louis Sauger", 45 m (MNHN); 18 sp, N Casamance 12° 46.9′ N 17° 29.9′ N "Louis Sauger", 45 m (MNHN); 39 s, 40 j, between Dakar and Gorée, dredged at 20-40 m (CER). Guinea Conakry: 1 s, W Kaporo N/O "André Nizery" Sedigui I, Sta. 276, 18 m, 9° 36′ N 14° 06′ W (MNHN); 5 c, 3 j, Baie de Sangarea N/O "André Nizery" Sedigui II, Sta. B12-13CH, 35 m, 9° 42′ N 15° 33′ W (MNHN); 1 s, W Ile Tannah, Sedigui I, Sta. 84. 9° 12′ N 13° 49.5′ W, 33 m (MNHN); 1 s, (CJH); 1 s, 09° 56′ N 15° 58′ W, 36 m (CJH). Benin: 2 s, Ouidah 06° 10′ N 02° 05′ E, 200 m (MNHN).
Type locality: Île de Los, Guinea Conakry, Expedition Sedigui I, Sta. 262, 9° 30′ N 13° 59′ W, 35 m.
Etymology: The specific name alludes to the fact that this species appeared while comparison between *C. chinensis* and *C. africana* was being made, and was not expected when the study was begun.

Description: Shell (Figs. 57-64, 68) with a patelliform shape and usually rounded at its base, relatively solid, not transparent, smooth but not shiny, sometimes with a rough surface. It has an elevated apex, and the profile usually shows a right or slightly convex line. The shell is not depressed. Ratio between width and height is between 1.8 and 2.4. The protoconch (Figs. 69-74) has approximately 1 whorl, with a nucleus of 142-215 µm in diameter. From this nucleus, the protoconch diameter increases quickly, to about 2.7-4.5 times that of the nucleus. The total diameter of the protoconch in the mater-



Figures 91-93: Drawing of the radulae of *Calyptraea*. C: central tooth; L: lateral tooth; M1, M2: marginal teeth. 91: *C. chinensis*, specimen of 13 mm, Vigo, Spain; 92: *C. africana*, specimen of 11 mm, Luanda, Angola; 93: *C. inexpectata*, specimen of 12 mm, Tacoma, Dakar.
Figuras 91-93: Dibujo de los dientes radulares de Calyptraea. *C: diente central; L: diente lateral; M1, M2: diente marginal. 91:* C. chinensis, *ejemplar de 13 mm, Vigo, España; 92:* C. africana, *ejemplar de 11 mm, Luanda, Angola; 93:* C. inexpectata, *ejemplar de 12 mm, Tacoma, Dakar.*



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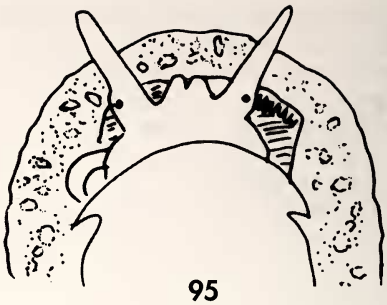

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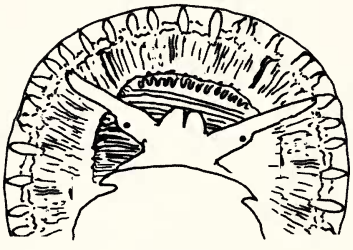

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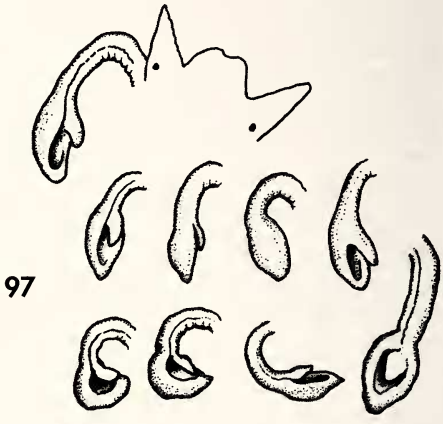

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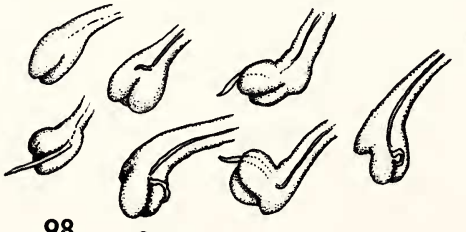

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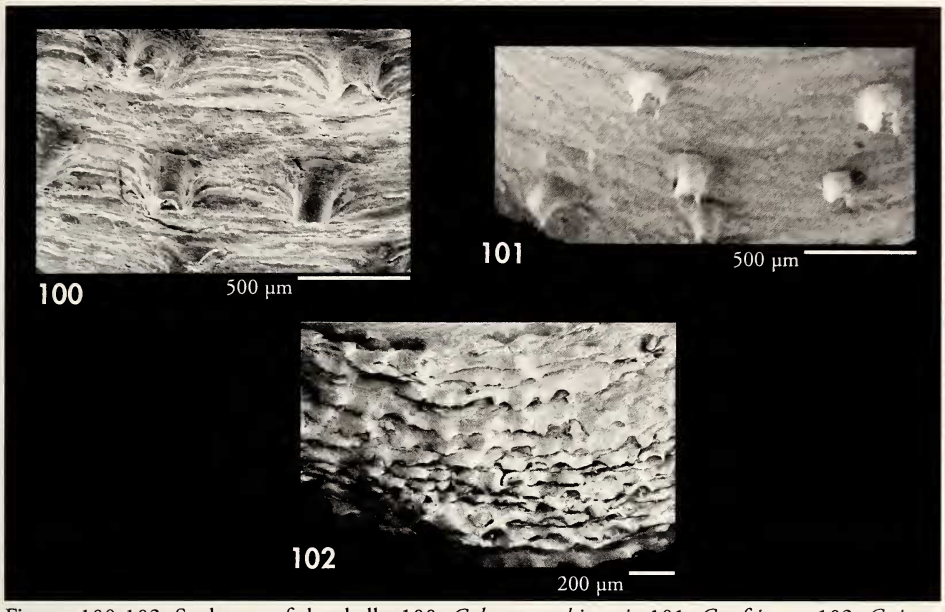
Figures 94-96: Diagram of the animal of *Calyptraea*. 94: *C. chinensis*, Vigo, Spain; 95: *C. africana*, Miamia, Ghana; 96: *C. inexpectata*, Dakar, Senegal. Figures 97-99. Penis of *Calyptraea*: 97: *C. chinensis* upper row, from Vigo, Spain, specimens; lower row: first 2, from O Grove, Galicia, Spain; the last 2 from La Atunara, Spain; 98: *C. africana*: upper row and first of the second from Miamia, Ghana; the rest form Luanda, Angola; 99: *C. inexpectata*, Dakar, Senegal.

Figuras 94-96: Esquema del animal de Calyptraea. *94:* C. chinensis, *Vigo; 95:* C. africana, *Miamia, Ghana; 96:* C. inexpectata, *Dakar, Senegal. Figuras 97-99. Pene de* Calyptraea*: 97:* C. chinensis *fila superior, ejemplares de Vigo, España; fila inferior: los 2 primeros, de O Grove, Galicia, España; los 2 últimos, de La Atunara, España; 98:* C. africana*: fila superior y primero de la segunda fila de Miamia, Ghana; el resto de Luanda, Angola; 99:* C. inexpectata, *Dakar, Senegal.*



Figures 100-102. Sculpture of the shells. 100: *Calyptraea chinensis*; 101: *C. africana*; 102: *C. inexpectata.*

Figuras 100-102. Escultura de las conchas. 100: Calyptraea chinensis*; 101:* C. africana*; 102:* C. inexpectata.

ial studied was 471-614 µm. In lateral view the periphery of the protoconch is not very prominent from the teleoconch, and the suture is shallow (Figs. 72, 73). The protoconch surface lacks any sculpture except for growth lines.

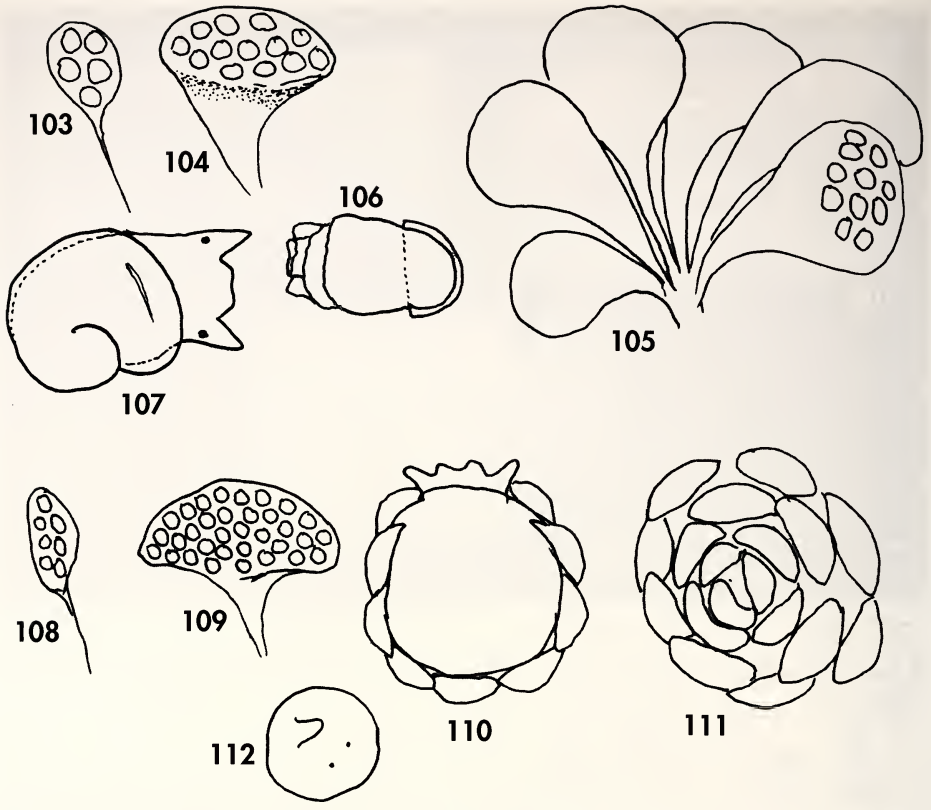
The teleoconch has at its beginning numerous growth lines crossed by spiral grooves (Figs. 69, 70, 74) which radiate from the protoconch; the teleoconch is opaque and not glossy, and in many shells spiral striae exist. Most of the shells have numerous wavy scales (Fig. 102), closer between them, which are usually absent in a short circle around the apex (Fig. 68). These scales are variable among populations, and are sometimes rare. Internally the shell is glossy.

The colour of the shell is whitish or brown, usually uniform, each shell with a single colour. Aperture rounded with the peristome frequently irregular, perhaps due to irregular substrate. Internally, a partition arises from the shell along a curved line running from the apex to near the aperture posteriorly.

Dimensions: in most of the populations the shells are only 5-7 mm, but in some, the largest shells reach 12 mm in maximum diameter.

The animal (Fig. 96), examined in five specimens (three females and 2 males) of the Dakar population, is whitish translucent with numerous milk-white opaque spots on the tentacles, the lips and the body. The mantle has very marked milk-white radiated fusiform blotches which reach the border. All of them are fused into a continuous line a little below the border, but continue towards the interior in other finer lines. The buccal lips have a darker tone. The males are very small (3 mm diameter). The penis observed in the two males studied (Fig. 99) is behind the right tentacle and difficult to see because it is in a dorsal position; it is cylindrical and simple, having two angulations.

Radula (Figs. 89, 90, 93) with a rachidian tooth narrow and with the central cusp not very prominent and up

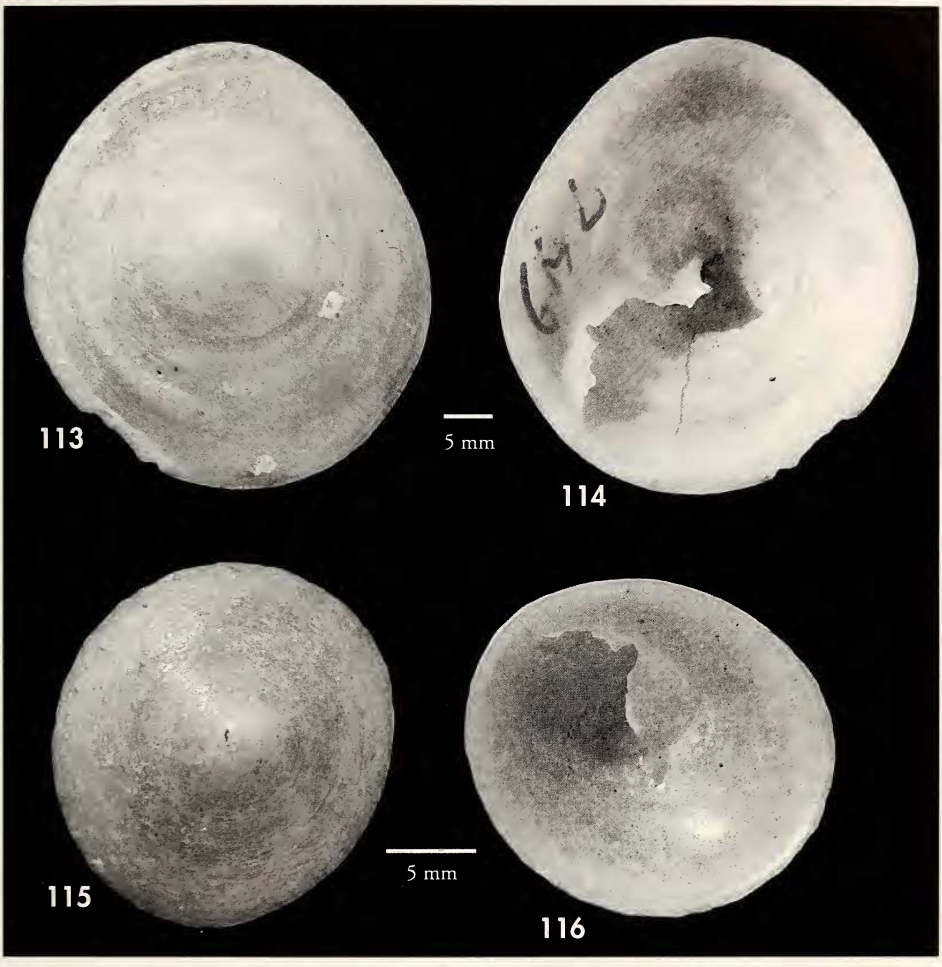


Figures 103-112. Spawn and larval specimens of *Calyptraea*. Figures 103-107. *C. chinensis* from Vigo. 103, 104: egg capsules; 105: group of egg capsules. 106, 107: larval specimens after the veliger period. Figures 108-112. *C. africana* from Miamia, Ghana. 108, 109: egg capsules; 110: position of the eggs with the animal on the substrate; 111: spawn removed the animal; 112: larval specimen.
Figuras 103-112. Puesta y ejemplares larvarios de Calyptraea. *Figuras 103-107.* C. chinensis *de Vigo. 103, 104: cápsulas; 105: grupo de cápsulas; 106, 107: ejemplares larvarios posteriores a la etapa velígera. Figuras 108-112.* C. africana *de Miamia, Ghana. 108, 109: cápsulas; 110: posición de las cápsulas con el animal sobre el sustrato; 111: puesta una vez retirado el animal; 112: ejemplar larvario.*

to 5 smaller cusps at each side. Lateral teeth with a cusp in the confluence of the internal and the external edges which has the same size as those in the internal edge (usually up to 5) while the external edge has more numerous cusps (16-20). Marginal teeth elongate, curved, sharply pointed and the internal ones with up to 22 cusps on the internal border and 4-6 on the external. The external teeth have up to 6 cusps on its internal part.

The spawn of *C. inexpectata* was probably examined by KNUDSEN (1950), because two of the populations mentioned in this work are from 34 and 50 m, which is the usual depth for this species. He mentioned 23 and 28 capsules per brood, with 9-29 eggs per capsule and a total between 239-274 eggs. Only one spawn of this species could be examined, but in poor conditions to count and measure capsules and eggs.

Distribution: *C. inexpectata* is known from Western Sahara (23° N) and Mauritania to Benin (6° N) (Fig. 117). It was not found in Ghana in spite of the many samples obtained from this country.



Figures 113-116. Types of *Calyptraea chinensis* in LS: 113, 114: Lectotype; 115, 116: Paralectotype.
Figuras 113-116. Tipos de Calyptraea chinensis *en LS: 113, 114: Lectotipo; 115, 116: Paralectotipo.*

This species has not been found in shallow water. The living material has been collected from 25 to 53 m, and empty shells from up to 600 m.

Discussion: *C. inexpectata* is different from the other species mentioned in the present work. The differentiating characters are listed in Table I, but they will be commented as follow:

C. chinensis is usually larger; the sculpture (when it is present) is more prominent and less dense; the shell width/height ratio is larger (2.5-3.1 vs. 1.8-2.4); the protoconch is rather similar, but a little larger and also the nucleus diameter is slightly larger, showing microsculpture which does not exist in *C. inexpectata*. The beginning of the protoconch in *C. chinensis* lacks the grooves present in *C. inexpectata*. The radula has fewer cusps on the lateral tooth, and the cusp in the confluence of the internal and external borders is larger; also, there are fewer cusps on the marginal teeth; the central tooth is wider.

C. africana has a larger shell, usually about 25 mm in diameter, and up to 28-32 mm, while *C. inexpectata* seldom reaches

Figure 117. Distribution range of *C. chinensis*, *C. africana* and *C. inexpectata*.
Figura 117. Área de distribución de C. chinensis, C. africana *y* C. inexpectata.

12 mm. Also, *C. africana* is ovoid in its aperture, more depressed, more transparent, shiny, with external sculpture (when present) formed by isolated and raised spicules, in contrast to the scaly concentric lines of *C. inexpectata*. The protoconch of *C. africana* is larger (in the commonest form), with a smaller nucleus, more prominent and deeper suture between the protoconch and the teleoconch. The radula has more cusps and some different details, such as the larger cusp in the confluence of the external and internal edges of the lateral tooth.

These two species co-occur, in Sahara-Mauritania, Senegal and Guinea Conakry. *C. africana* was collected in beach sediments at a few meters depth, while *C. inexpectata* was collected in deeper water, at least 30-50 m, but sometimes deeper (shells collected frequently in 70-100 m, up to 600 m), where no shells of *C. africana* were found.

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